CLAIMS

1. A method of determining error magnitudes in Reed-Solomon decoding, wherein a vector of $v$ syndromes $E_i$ and $v$ error locations $l_j$ are determined from a received codeword, and error magnitudes $e_{l_j}$ at the $v$ error locations can be determined from the equation $E_i = \sum_{j=1}^{v} e_{l_j} a^{il_j}$, where $a$ is a primitive of the codeword, comprising the steps of:

triangularizing a $v$x$v$ Vandermonde matrix of the elements $a^{il_j}$ to generate elements of a matrix **V**;

generating a syndrome vector **W** of syndromes $E_i$, adjusted for the triangularization of matrix **V**;

generating a solution to an equation of a form **V***x* **M**=**W**, where **M** is a vector of the error magnitudes $e_{l_j}$ and **V***x* is a vector of matrix **V**, having a single unknown error magnitude;

substituting to create other equations of the form **V***x* **M**=**W** having a single unknown that can be solved for a respective error magnitude.

2. The method of claim 1 wherein said triangularizing step comprises the step of recursively generating vectors of **V**.

3. The method of claim 2 wherein said recursively generating step comprises the steps of:

setting a first vector **V**(1) of matrix **V**; and

generating subsequent vectors $n$, $2 \leq n \leq v$, as:

$$V(n)=(V(1) + R(A(n-1))_{v-n+1})V(n-1)$$

where $A(n)$ is equal to $a^{l_n}$ and $R(A(n))_m$ is a vector having $A(n)$ replicated $m$ times.

4. The method of claim 3 wherein said step of setting the first vector comprises setting the first vector **V**(1) to {A(1) A(2) … A($v$)}.

5. The method of claim 1 wherein said step of generating a syndrome vector comprises the step of recursively generating elements of **W**.

6. The method of claim 5 wherein said step of recursively generating elements of **W** comprises the steps of:

for each element **W**($n$):

generating a vector $T(n)=R(A(n))_n*T(n-1) + T(n-1)<<1$, where $R(A(n))_m$ is a vector having A($n$) replicated $m$ times and is $T(n-1)<<1$ is a previous value of T, left-shifted and right-filled with a "0";

generating a vector U(n)=T(n-1)*{E(n) E(n-1) … E1} and computing **W**(n) as the sum of the elements of U(n).

7. A method of Reed-Solomon decoding, comprising the steps of:

generating a vector of $v$ syndromes $E_i$ from a received codeword;

generating $v$ error locations $l_j$ from the received codeword,

determining error magnitudes $e_{l_j}$ at the $v$ error locations from the equation $E_i = \sum_{j=1}^{v} e_{l_j} a^{il_j}$, where $a$ is a primitive of the codeword by:

triangularizing a $v$x$v$ Vandermonde matrix of the elements $a^{il_j}$ to generate elements of a matrix **V**;

generating a syndrome vector **W** of syndromes $E_i$, adjusted for the triangularization of matrix **V**;

generating a solution to an equation of a form **V**$x$ **M**=**W**, where **M** is a vector of the error magnitudes $e_{l_j}$ and **V**$x$ is a vector of matrix **V**, having a single unknown error magnitude,

substituting to create other equations of the form **V**$x$ **M**=**W** having a single unknown that can be solved for a respective error magnitude..

8. The method of claim 7 wherein said triangularizing step comprises the step of recursively generating vectors of **V**.

9. The method of claim 8 wherein said recursively generating step comprises the steps of:

setting a first vector **V**(1) of matrix **V**; and

generating subsequent vectors $n$, $2 \leq n \leq v$, as:

$$V(n)=(V(1) + R(A(n-1))_{v-n+1})V(n-1)$$

where $A(n)$ is equal to $a^{l_n}$ and $R(A(n))_m$ is a vector having $A(n)$ replicated $m$ times.

10. The method of claim 9 wherein said step of setting the first vector comprises setting the first vector **V**(1) to {A(1) A(2) … A($v$)}.

11. The method of claim 7 wherein said step of generating a syndrome vector comprises the step of recursively generating elements of **W**.

12. The method of claim 7 wherein said step of recursively generating elements of **W** comprises the steps of:

for each element **W**($n$):

generating a vector $T(n)=R(A(n))_n*T(n-1) + T(n-1)<<1$, where $R(A(n))_m$ is a vector having $A(n)$ replicated $m$ times and is $T(n-1)<<1$ is a previous value of T, left-shifted and right-filled with a "0";

generating a vector U(n)=T(n-1)*{E(n) E(n-1) … E1} and

computing **W**(n) as the sum of the elements of U(n).

13. A Reed-Solomon decoder comprising:

circuitry for generating a vector of $v$ syndromes $E_t$ from a received codeword;

circuitry for generating $v$ error locations $l_j$ from the received codeword,

circuitry for determining error magnitudes $e_{l_j}$ at the $v$ error locations from the equation $E_t = \sum_{j=1}^{v} e_{l_j} a^{tl_j}$, where $a$ is a primitive of the codeword by the operations of:

triangularizing a $v$x$v$ Vandermonde matrix of the elements $a^{tl_j}$ to generate elements of a matrix **V**;

generating a syndrome vector **W** of syndromes $E_t$, adjusted for the triangularization of matrix **V**;

generating a solution to an equation of a form **V**$x$ **M=W**, where **M** is a vector of the error magnitudes $e_{l_j}$ and **V**$x$ is a vector of matrix **V**, having a single unknown error magnitude;

substituting to create other equations of the form **V**$x$ **M=W** having a single unknown that can be solved for a respective error magnitude.

14. The Reed-Solomon decoder of claim 13 wherein said circuitry for determining error magnitudes comprises circuitry for recursively generating vectors of **V**.

15. The Reed-Solomon decoder of claim 14 wherein said circuitry for recursively generating vectors comprises circuitry for:

setting a first vector **V**(1) of matrix **V**; and

generating subsequent vectors $n$, $2 \le n \le v$, as:

$$V(n)=(V(1) + R(A(n-1))_{v-n+1})V(n-1)$$

where $A(n)$ is equal to $a^{l_n}$ and $R(A(n))_m$ is a vector having $A(n)$ replicated $m$ times.

16. The Reed-Solomon decoder of claim 15 wherein said circuitry for determining error magnitudes sets the first vector **V**(1) to {A(1) A(2) … A($v$)}.

17. The Reed-Solomon decoder of claim 13 wherein said circuitry for determining error magnitudes generates a syndrome vector by recursively generating elements of **W**.

18. The Reed-Solomon decoder of claim 13 wherein said circuitry for generating error magnitudes recursively generates elements of **W** by:

for each element **W**($n$):

generating a vector $T(n)=R(A(n))_n*T(n-1) + T(n-1)\ll 1$, where $R(A(n))_m$ is a vector having $A(n)$ replicated $m$ times and is $T(n-1)\ll 1$ is a previous value of T, left-shifted and right-filled with a "0";

generating a vector $U(n)=T(n-1)*\{E(n)\ \ E(n-1)\ \ \ldots\ \ E1\}$ and

computing **W**(n) as the sum of the elements of U(n).